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(54) **Thin sheet feeding apparatus.**

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Thin sheet feeding apparatus

The present invention relates to a thin sheet feeding apparatus including: a rotating drum arranged facing the surface of the topmost sheet of a pile of thin sheets and rotating while repeating predetermined periodical acceleration and deceleration, said drum having at least one suction area on the circumferential wall thereof where a plurality of suction holes are arranged to suck the topmost thin sheet: means for rotating the drum; negative pressure applying means for applying negative pressure to said suction holes only when said suction holes are positioned by the rotation of said drum between predetermined suction starting and stopping points to suck and move the topmost thin sheet only by a predetermined distance and then to allow the topmost thin sheet to be fed in a predetermined direction; and belt conveyor means arranged axially on both sides of said drum and each of said belt conveyor means having a pair of belts for conveying thin sheets and a plurality of pulleys for defining the running paths of said belts, said running path including a thin sheet holding portion where each of the thin sheets fed by said drum is held between said belts and conveyed to a predetermined place; said belts having first and second running sections which form a V-shaped area for receiving the thin sheet fed from the drum and guiding it to the thin sheet holding portion, said first and second running sections forming a wide skirt portion on the thin sheets receiving side and a tip portion which becomes narrower as it comes nearer to the thin sheet holding portion, and the pulley for defining the first running section to form the skirt portion having a diameter smaller than that of said drum and being arranged eccentrically relative to said drum, the axis of said pulley being independent of that of the drum.

Such a thin sheet feeding apparatus is known from US—A—4 095 781.

With this known construction guide plates are necessary and must be provided in the V-shaped area in order to provide guiding means for the thin sheets. Furthermore, with this known construction the suction holes are arranged in a single axially-extending line.

From DE—A—2 926 136 a sheet feeding apparatus is known with which a pair of belt conveyor means is provided forming a V-shaped area to receive thin sheets one by one from a suction apparatus and convey them to a predetermined place, without the aid of further guide members.

Usually the sheets of various type, data cards, for example, are stored in a piled condition. For the purpose of using information recorded on these cards is needed a device for picking up these cards one by one and feeding them to the reader. Figs. 1 and 2 show schematically a main portion of conventional thin sheet feeding apparatus. Numeral 101 represents a case whose upper end is opened and housing above the bottom thereof a pushing plate 103 always urged upwards by a spring 102. Sheets of paper, data cards, for example, are piled on the pushing plate 103 in the case 101. The right upper end of case 101 is provided with a stopping edge 105 and the topmost one of data cards piled on the pushing plate 103 is usually held at a certain position by the action of the stopping edge 105 and the spring 102. Above the left side of the case 101 is arranged, not contacted, a rotating cylindrical drum 106 with its both ends closed and its rotating axis crossing perpendicular to the surface of the drawing Fig. 1. Two suction holes 107 are formed opposite to each other in the circumferential wall of the drum 106 and a suction nozzle 108 having a suction chamber 108a adjacent and opposite to the inner face of the drum 106 is arranged in the drum 16 to be stationary relative to the case 101, as shown in Fig. 2. The suction nozzle 108 is communicated with a suction pump (not shown). Above the left side of the case 101 and below the drum 106 is arranged an ejection nozzle 109 communicated with a discharge pump (not shown) and air is ejected through the ejection nozzle 109 to the side of the data cards stacked. A shielding member 110 is arranged adjacent to the ejection nozzle 109 and extending to the drum 106 and the space between the shielding member 110 and the drum 106 is set to have a value larger than the thickness of one sheet of the data card but smaller than that of two sheets thereof. Above the left side of case 101 and adjacent to the drum 106 are further arranged conveyor belts 111 and 112 which run substantially in upward and downward directions and which are stretched around respective groups of pulleys including guide pulleys 111a and 112a. Pulleys 111a and 112a are positioned in such a way that running belts 111 and 112 are partially overlapped with each other to form a data card holding portion 113 where data cards are successively held and fed between overlapped running belts 111 and 112.

When the drum 106 is rotated in the direction shown by an arrow and a suction pump and a discharge pumps are operated, the left end portion of the topmost data card is sucked by the drum 106 every time when either of suction holes 107 formed in the drum 106 comes to the front of suction chamber 108a of suction nozzle 108, that is, when either of the suction holes 107 comes above the left end portion of the topmost data card 104, so that the data card 104 sucked is shifted to the left by the rotation of the drum 106. The card shifted is held between belts 111 and 112 and fed to the card reading device, for example. Even if the drum 106 sucks two or more sheets of data

card, the shielding member 110 serves to cause only the topmost one to be shifted.

This conventional device is useful but still has something to be improved. Namely, the positioning of shielding member 110 is difficult. Since the topmost data card is shifted to the position of belts with its front end portion only sucked, the front end portion of the data card must be kept sucked until the reliable shift of the card to the belts is attained. Therefore, if the opening of suction nozzle 108 facing the inner face of drum 106 is made large and the amount of air leakingly entering from outside into the suction chamber 108a becomes large the degree of vacuum inside the suction chamber 108a is reduced, thus making it impossible to suck and shift data cards when high speed feeding of the data cards is intended, for example. In addition, since the data card is sucked only at the front end portion thereof, the other portion thereof is left free and vibrated to cause positional displacement in the horizontal direction and sound at the time of high speed shift. Further, the data card is held between belts 111 and 112 after the front end portion of data card is released from the outer circumference of the drum 106 and dropped onto the belt 112, so that the front end portion of the data card is bent or rumpled when dropped onto the belt 112 to thereby cause jam.

To overcome these drawbacks, it was proposed that a plurality of suction holes 107 are respectively arranged at areas spaced from each other to have an angle of 180°. It was proposed that the running way of one of belts 111 and 112 is changed to form a V-shaped area which defines a skirt portion progressively narrowing toward the data card holding portion 113 so as to smoothly guide and feed the data card sucked by the drum 106 to the data card holding portion 113. However, since the drum itself, or the outer wheel of the drum bearing is employed as the pulley 111a used to change the running path of the belt and form the skirt portion the device thus formed is not suitable for high speed operation. In addition, the roller bearing or the like employed as the pulley inevitably becomes bulky and obstacles such as dust generated from the sheets are allowed to easily enter into the comparatively wide clearance between outer and inner wheels, thus causing accidents often. Accordingly, it has been desired that a device for conveying thin sheets and capable of overcoming these drawbacks is developed.

The object of the present invention is to provide an apparatus for feeding thin sheets which have an improved driving mechanism so that the drum is temporarily stopped to suck the topmost data card, when its front end suction hole arrives at a predetermined position.

To attain this object in an apparatus of this invention the means for rotating the drum are including a housing arranged coaxially with the drum and rotatably connected to the drum; a sun gear fixed to the housing; a plurality of planet gears engaged with the sun gear and driven in such a way that they rotate both round the sun gear and on their own axes; connection bars for connecting the eccentric positions of said planet gears the eccentric portion of said drum; and means for driving said planet gears at a constant speed.

When the apparatus of the present invention having such an arrangement as described above is used, many advantages are obtained.

First, the small size of the pulley produce some successive good results that the bearings of the pulley is also small, that grease in the bearing does not break out of the bearing because of the small centrifugal force applied to the pulley, therefore the apparatus of this invention comes to be adapted for high speed operation, that the load of the bearing is decreased; and that as the circumferential length is short, incoming dust from the outside is prevented resulting the apparatus to be suitable for high speed operation.

Second, the fact that the pulley has a different and independently arranged shaft produce some good effects that in case of interchanging the construction parts of the pulley, easy interchange of the parts accordingly easy inspection, maintenance and assembly of the pulleys defining the V-shaped area is obtained without a process of disassembling the unrelated construction member such as the drum.

Third, in this apparatus as the V-shaped area is provided and the traveling speed of the belt is determined higher than that of the periphery of the drum, crumples of the sheet supplied into the V-shaped area are smoothed by the rubbing up action of the belts until the thin sheet is pulled into the data card holding portion thereby bending and vibration of the data card is effectively prevented.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is an explanatory view showing a main portion of conventional thin sheet feeding apparatus;

Fig. 2 is a sectional view taken along a line 2—2 in Fig. 1;

Fig. 3 is a front view showing a thin sheet feeding apparatus according to the present invention;

Fig. 4 is a sectional view taken along a line 4—4 in Fig. 3;

Fig. 5 is a sectional view taken along a line 5—5 in Fig. 4;

Fig. 6 is a sectional view taken along a line 6—6 in Fig. 4;

Fig. 7 is a sectional view taken along a line 7—7 in Fig. 3;

Fig. 8 is a graph showing relations between the rotating angle θ of a planetary-type gear shown in Fig. 6 and the rotating speed H of the drum and between the rotating angle θ of

planetary-type gear and the rotating acceleration K of the drum;

Figs. 9A to 9E show how the topmost sheet is sucked from the pile of the thin sheets and fed by the drum to the sheet holding portion; and

Figs. 10, 11 and 12 show various positions of pulley for positioning the running paths of belts to form the V-shaped area.

An embodiment of the present invention will be now described with reference to the drawings.

Fig. 3 is a view showing a main portion of an embodiment of the thin sheet feeding apparatus according to the present invention.

Numeral 15 represents a frame, to which upper and lower bearings 16a and 16b, opposite to each other, are fixed through support members. A screw rod 17 is freely rotatably supported by these bearings 16a and 16b. The upper end portion of screw rod 17 is connected to the rotating shaft of a motor 19 through a speed reduction mechanism 18. A nut 20 is threaded onto the screw rod 17 and to this nut 20 is horizontally fixed a table plate 21 on which thin sheets such as data cards 25 are stacked. Above the table plate 21 is arranged a position detector 22 consisting of a limit switch or the like, which applies an off-signal when the topmost one of data cards stacked on the table plate 21 contacts with the position detector 22 but an on-signal when not contacts. The motor 19 is rotated by the on-signal so as to elevate the nut 20 in the direction shown by an arrow. Therefore, the topmost data card is always kept to a certain level. The motor 19 is controlled by external operation to be reversed and stopped selectively.

On the left side of the table plate 21 is arranged a suction cylinder 24 of rectangular shape to define the left side of the data cards 25 stacked on the table plate 21. The upper end of suction cylinder 24 is positioned substantially same level as the topmost data card 25 and closed by a plate 26 as shown in Fig. 7. The plate 26 is provided with suction holes 27 which are arranged in five lines and three columns, for example. The lower end of suction cylinder 24 is connected to a suction pump P1. On both upper sides of the suction cylinder 24 are arranged a pair of ejection cylinders 28a and 28b with the upper portion of suction cylinder 24 and the left end portion of stacked data cards 25 interposed therebetween. Each of walls of ejection cylinders 28a and 28b facing stacked data cards 25 is provided with ejection nozzles H which are arranged in a line in the direction in which data cards 25 are stacked. Ejection cylinders 28a and 28b are connected to a compressor C1.

Above the left end portion of the table plate 21, that is, above the suction cylinder 24 is arranged a rotating drum 29 with its axis crossing transversely and perpendicular to the surface of the drawing (Fig. 3). The rotating drum 29 is rotated in the direction shown by an arrow and formed to have a width smaller than that of the data card 25 as shown in Fig. 4. Friction members 32 are respectively fixed on the outer circumference 29a of the drum 29 at two positions spaced by 180 degrees from each other as shown in Fig. 5. A plurality of suction holes 30 are distributed axially and along the outer circumference of the drum 29 passing through each of friction members 32 and the circumferential wall 29a of the drum 29, said suction holes 30 being arranged in a matrix and forming a group of suction holes at two positions, respectively. Friction members 32 are made of rubber, plastics or the like which has a large coefficient of friction relative to the data cards 25. Areas where suction holes 30 are formed will be hereinafter referred to as suction areas 31a and 31b, and suction holes 30 bored at most leading position with respect to the rotating direction of the drum 29 will be hereinafter referred to as a front end suction hole 30a while suction holes 30 at most lagging position will be hereinafter referred to as a back end suction hole 30b.

As shown in Figs. 4 and 5, a suction nozzle 33 is stationarily housed in the drum 29. The suction nozzle 33 has a suction chamber 33c which is opened adjacent to the inner face of a circumferential wall 29a of the drum 29. The width of the suction chamber 33c in the rotating direction of the drum 29 is defined by a suction start wall 33a and a suction stop wall 33b which extend substantially parallel to each other toward the circumferential wall 29a. Points at which straight lines extending from the suction start wall 33a and the suction stop wall 33b cross the inner circumferential wall 29a will be hereinafter referred to as suction start point 23a and suction stop point 23b, respectively. The suction start point 23a is positioned 3—8 mm remote from the left side end of the stacked data cards 25 in a direction reverse to the rotating direction (which will be hereinafter referred to as positive direction) of the drum 29. The suction stop point 23b is also positioned to be on a side reverse to the positive direction from a point at which a belt 71, which will be described later, crosses the circumferential wall 29a of the drum 29.

Providing in the drum 29 and the suction nozzle 33 positioned as described above that the circumferential length along which the inner face of circumferential wall 29a of the drum 29 is moved during a time period when all of suction holes 30 in a group pass from the suction start point 23a to the suction stop point 23b is l_1 mm, the whole circumferential length of rotating drum 29 is L mm and the radius ratio of a sun gear 48 to planet gears 49, 50 is n, the relation between the circumferential length l_1 mm and the length l_2 mm along the inner face of the drum 29 from the suction start point 23a to the suction stop point 23b is designed as follows: